SPECIFICATIONS

FOR

TWO HORIZONTAL DIRECT-ACTING

Triple-Expansion Screw-Engines

FOR

GUNBOAT No. 1,

OF 1,700 TONS DISPLACEMENT,

TO BE NAMED THE

EACH ENGINE WITH ITS AUXILIARIES OF 1,500 I. H. P.

UNDER FORCED DRAUGHT;

INCLUDING

BOILERS, SCREW-PROPELLERS, AND ALL APPENDAGES AND APPURTENANCES COMPLETE, TOGETHER WITH A LIST OF TOOLS, INSTRUMENTS, AND DUPLICATE PIECES TO BE FURNISHED.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

SPECIFICATIONS

FOR

TWO HORIZONTAL DIRECT-ACTING

Triple-Expansion Screw-Engines

FOR

GUNBOAT No. 1,

OF 1,700 TONS DISPLACEMENT,

TO BE NAMED THE

EACH ENGINE WITH ITS AUXILIARIES OF 1,500 I. H. P.

UNDER FORCED DRAUGHT;

INCLUDING

BOILERS, SCREW-PROPELLERS, AND ALL APPENDAGES AND APPURTENANCES COMPLETE, TOGETHER WITH A LIST OF TOOLS, INSTRUMENTS, AND DUPLICATE PIECES TO BE FURNISHED.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1887.

INDEX.

Page.

A.

Acceptance, conditions of, (material) 47
Air, circulating, and bilge-pumps 14
Air-tight fire-rooms 36
Angles, beams, &c 48
Ash-hoists 36
Ash-pit doors 29
Ash-sprinklers 41
Attachments, boiler 25
Auxiliary feed-pumps 16
Auxiliary steam-pipes and valves 32

B.

Back connections and uptakes 28
Beams, bulb bars, &c 48
Bearings, crank-shaft 12
Bearings, mandrels for 41
Bearings, spring 21
Bearings, stern-pipe 20
Bearings, thrust 21
Bed-plates 12
Bilge and fire-pumps 16
Bilge injection 15
Bilge-pump, centrifugal 14
Bleeders 32
Blowers 35
Blow-pipes 33
Blow-valves 33
Boilers 25
Boiler braces 27
Boiler clothing 30
Boiler drain-cocks 34

Page.

Boiler material 48
Boiler shells 26
Boiler stop-valves 33
Boiler tests 32
Boiler tubes 26
Bolts, holding-down 6
Boxes, journal 22
Braces, boiler 27
Brake, friction 21
Brass pipes, thickness of ... 40
Brasses, crank-shaft 12
Bridge-walls 27

C.

Capstan 25
Centrifugal bilge-pump 14
Check-valves 32
Circulating-pumps 14
Condensers 12
Connecting-rods 11
Combustion chambers 28
Copper pipes, thickness of .. 40
Crank-shafts 12
Crank-shaft boxes and caps. 12
Cross-head slides 11
Cross-heads, piston-rod 11
Cylinder casings 5
Cylinder-heads and covers .. 5
Cylinder linings 5
Cylinder relief-valves 10
Cylinders, pump 17

Page.

D.

Delivery-valves, outboard .. 15
Distiller 16
Distiller-pump 16
Doors, ash-pit 29
Doors, furnace 28
Drain-cocks, boiler 34
Drain-pipes and traps 25
Drain-valves, cylinder..... 10
Dry-pipes 30
Duplicate pieces 37

E.

Engines, securing in ship... 24
Escape-pipes 34
Evaporator 16
Exhaust-main, auxiliary..14, 41
Eye-bolts 24

F.

Failure, case of (materials) . 47
Feed and blow-pipes..... 33
Feed-pumps, auxiliary..... 16
Feed-pumps, main..... 16
Feed-tank..... 18
Fire-main 23
Fire-pumps 16
Fire-rooms, air-tight 36
Floor-plates 35
Friction-brake 21
Furnaces..... 27
Furnace-doors..... 28
Furnace-fronts 28

Page.

G.

Gauges, water..... 31
General description 2
Governors 9
Grate-bars 26
Grate-surface 26

H.

Heads, boiler..... 27
Heads, cylinder 5
Holding-down bolts 6
Holes through ship..... 23
Hot-well or feed-tank 18
Hydrokineter 37

I.

Indicator fittings and motions 22
Indicators, revolution 22
Injection-valves 15
Inspectors, instructions to.. 45
Instruments, tools, &c 38

J.

Journal-boxes 22

Page.

L.

Line-shaft 19
Linings, cylinder 5

M.

Mandrels for bearings 41
Man-holes and plates, cylinder 6
Man-holes, boiler 29
Materials and workmanship. 42
Materials, boiler 48
Materials, conditions of acceptance 47
Materials, tests of 37

O.

Oil-cups 22
Oil-tanks, cans, &c 38
Outboard delivery-valves ... 15

P.

Pipe clothing 34
Pipe, smoke 29
Pipes, auxiliary steam 32
Pipes, dry 30
Pipes, escape 34
Pipes, feed and blow 33
Pipes, schedule of thickness of 40
Pipes, steam, main 33
Pipes through bulkheads ... 34
Pipes, water 21
Pistons, main 10
Piston-rod stuffing-boxes ... 11
Piston-rods 10
Piston-valves, main 7

Page.

Platforms, working 18
Propeller-shafts 19
Propellers 20
Pump-connections to fire-main 23
Pump-cylinders 17
Pump for distiller 16
Pumps, air 14
Pumps, bilge 14, 16
Pumps, circulating 14
Pumps, feed, auxiliary 16
Pumps, feed, main 16
Pumps, fire 16

Q.

Quenching tests 47

R.

Radiators 41
Receivers 5
Relief-valves, cylinder 10
Reversing-gear 9
Revolution indicators 22
Rods, connecting 11
Rods, piston 10
Rivets 48

SPECIFICATIONS

FOR

TWO HORIZONTAL DIRECT-ACTING

TRIPLE-EXPANSION SCREW-ENGINES

AND

BOILERS

FOR

GUNBOAT No. 1,

OF 1,700 TONS DISPLACEMENT.

REFERENCE BEING HAD TO THE ACCOMPANYING DRAWINGS, WHICH ARE TO FORM A PART OF THESE SPECIFICATIONS.

GENERAL DESCRIPTION:

The engines are to have, each, a high, intermediate, and low-pressure cylinder of 22, 31, and 50 inches diameter respectively, and a piston-stroke of 30 inches.

The engines will be placed in separate water-tight compartments, and will be duplicates, the low-pressure cylinder being forward in the forward, and aft in the after compartment; the forward engine turning the port-propeller.

The main steam-valves are to be of the piston type; there will be one for the high-pressure, one for the intermediate, and two for each low-pressure cylinder, worked by radial

valve-gear and arranged for a minimum cut-off of 0.4 of the stroke in the high-pressure and 0.5 in the intermediate and low-pressure cylinders.

Each piston is to have one piston-rod secured to a cross-head, which will run on guides, bolted to its cylinder at one end and bolted to bed-plate at the other.

Each crank-shaft will be a solid forging, made of steel, in one piece, with cranks at equal angles and with the necessary coupling-discs forged on.

The castings containing the crank-shaft bearings will be cast in one piece for each engine. They will be bolted to engine-keelsons; and stayed to cylinders by steel tie-rods and the guides.

There will be a centrifugal pump in forward engine-room, driven direct by its engine, and arranged for freeing the ship from water in case of necessity.

Each main engine will have one air, one circulating, and two bilge-pumps, all vertical and single acting, driven by an independent horizontal compound engine. Each circulating-pump to be arranged with bilge as well as sea injection, and with a suitable bye-pass valve. Each air-pump to deliver into a feed-tank of boiler-iron placed near the air-pump delivery-valves. Each tank will have a capacity of about 150 gallons and will be partitioned and fitted as a filter.

The shells of condensers will be cylindrical and made of brass. They will be fitted with brass tubes $\frac{5}{8}$ inch diameter outside; and will have, each, a cooling surface of about 2,450 square feet measured on the outside of the tubes. The tubes will be placed fore-and-aft, the water circulating through them and thence overboard through outboard delivery-valves.

Suitable baffling and supporting plates will be arranged in each condenser to assist in the circulation of steam and to support the tubes.

There are to be two vertical duplex pumps fitted in each fire-room of ample capacity for feeding the boilers. One set in each fire-room will be fitted to draw from feed-water tank and bottom of forward condenser and discharge through boiler

check-valves. The second set in each fire-room will be fitted to draw water from tank, sea, bilge, and boilers, and to discharge into fire-main, through boiler-checks, and overboard. The pump in forward fire-room to likewise discharge through distiller.

A horizontal pump of 200 gallons capacity per minute is to be placed in each engine-room, and fitted to draw water from the sea and bilge, and to discharge into fire-main and through outboard-delivery.

The water-cylinders and chests of all pumps are to be of composition.

The distilling apparatus will be located where directed, and will consist of one evaporator and distiller capable of furnishing 2,000 gallons of potable water in twenty-four hours. The circulating water for the distiller will be supplied by the auxiliary pump in forward fire-room. There will be a steam-pump conveniently located for feeding the evaporators. It will have a capacity equal to a No. 0 Blake pressure-pump, and will draw water from the sea and deliver through a check-valve on the evaporator.

The propellers are to be three-bladed, right-and-left-handed, respectively, of about 10 feet 6 inches diameter, and will be made of manganese bronze.

There will be four cylindrical horizontal tubular boilers, containing an aggregate grate-surface of 220 square feet, arranged fore-and-aft, in two water-tight compartments, each with a fire-room athwart-ship abaft the after boilers and forward of the forward boilers; the width of fire-rooms to be 8 feet. Each boiler will be 9 feet 9 inches in diameter and about 17 feet 6 inches long.

The smoke-pipe will be fixed, and its top will be about 55 feet above the grates.

Both fire-rooms are to be arranged to work under air-pressure when required, and to be fitted, each, with two blowers capable of supplying continuously, with ease, sufficient air for the required horse-power.

DETAILED DESCRIPTION.

CYLINDER-CASINGS.

The cylinder-casings, which will include the steam and exhaust ports and passages, inboard heads, valve-chests, and sole-plates, are to be of cast-iron.

They will be fitted with cylinder linings of hard cast-iron.

The cylinder-casings will have extensions cast on them with flanges 1½ inches thick for securing them to engine seatings.

The cylinder-casings and covers, after being placed in the ship, are to be covered with non-conducting material, and neatly lagged with black walnut, removable where directed.

RECEIVERS.

The receivers will consist of the spaces between high-pressure and intermediate, and intermediate and low-pressure piston-valves and their connecting pipes.

There will be a 2½-inch copper pipe, with composition stop-valve, connecting main steam-pipe to each receiver space; and a composition safety-valve, with nickel seat of 2 inches diameter on each receiver, the intermediate pressure weighted to 80 pounds per square inch above the atmosphere, and the low-pressure to 30 pounds.

CYLINDER-LININGS.

The linings are to be of cast-iron as hard as tools can work. They will be one inch thick and will be accurately fitted and secured to the casings. They are to be smoothly and accurately bored to diameters of 22, 31, and 50 inches respectively, and for a piston-stroke of 30 inches.

CYLINDER-HEADS AND COVERS.

The cylinder-heads are to be cast solid with cylinder-casings and amply stiffened by ribs. They will have suitable openings for the stuffing-boxes. The cylinder-covers are to be made of the best cast-iron, well-ribbed, of the same thickness as

the cylinder-heads. Each low-pressure cover will have a man-hole cast in, which will be bored and faced to receive the man-hole plate. The cylinder-covers are to be faced true on the inside. They are to have faced flanges, and are to be secured to cylinder-casings by wrought-iron bolts with finished nuts. Bolts are to be spaced not over 6 inches apart.

HOLDING-DOWN BOLTS.

All holding-down bolts for securing the engines in the ship are to be fitted with locked nuts.

MAN-HOLES AND PLATES.

The man-holes in low-pressure cylinder-covers are to be 15 inches in diameter. The plates are to be turned to loosely fit the holes, faced on the inner surface to fit the facing-strip on cover or head, and to be finished on the outside.

VALVE-CHESTS AND COVERS.

The valve-chests will have openings at each end for inserting and removing the valves, and will be closed by single-plate covers of cast-iron, well ribbed, finished on outside with faced flanges $2\frac{3}{4}$ inches wide and $1\frac{1}{4}$ inches thick.

The inboard and outboard covers will contain the valve-stem stuffing-boxes. The packing spaces will be fitted with metallic packing. The covers will be secured in place by one-inch bolts, spaced not over 6 inches apart, and with finished wrought-iron nuts. Suitable bosses will be cast on the upper surface of steam-chests, directly over each steam-port, for the attachment of approved oil-cups.

VALVE-LINERS.

The valve-liners are to be made of cast-iron of the toughest quality, combined with a suitable degree of hardness. They are to be $\frac{7}{8}$ inch thick, accurately bored and turned; then forced into seats after the ports have been cut out $2\frac{7}{8}$ inches wide. The bridges in ports are to be 1 inch and $1\frac{1}{4}$ inches wide.

MAIN STEAM PISTON-VALVES.

The piston-valves of the high-pressure cylinders will be made of cast-iron, the thickness of metal in the body of the valves being $\frac{7}{16}$ inch. The intermediate and low-pressure piston-valves will be made of composition, $\frac{5}{16}$ inch thick in the body of the valve.

Each end of all valves will be made steam-tight by two packing-rings of composition, $\frac{5}{8}$ inch square in cross-section, cut obliquely and tongued, and held in place by a composition follower and wrought-iron bolts. The distance pieces for separating the packing-rings at each end of the valves will be made of cast-iron for the high-pressure and of composition for the intermediate and low-pressure valves.

MAIN VALVE-STEMS.

The valve-stems will be made of steel, $1\frac{1}{2}$ inches diameter where they pass through the valves, and 2 inches diameter in the stuffing-boxes.

THROTTLE-VALVES.

The main steam-throttle for each high-pressure cylinder will consist of a disc-valve, 8 inches diameter of opening, closing against the pressure in the steam-pipe, and operated by suitable gear with hand-lever adjacent to hand-lever of steam-reversing gear.

VALVE-GEAR.

The valve-gear is to be of the radial type. The cut-offs of all cylinders are to be capable of being adjusted independently of each other.

The distribution of steam in backward gear must be such as to permit the engines to be reversed quickly and to run astern at full power.

The eccentrics are to be made of cast-iron or steel. Each eccentric is to be made in two parts, securely fastened together by two mild-steel bolts. They are to be truly bored

to fit the shaft, and properly secured to the same. They are to be truly turned to a suitable eccentricity, and recessed at the sides to fit the flanges of the eccentric-straps.

Each eccentric-strap is to be in two parts, of cast-steel, with white-metal lining. The two parts are to be firmly fastened together by two mild-steel bolts with lock-nuts. The two parts of the strap are to be separated by suitable brass chipping pieces. A prolongation of one part of each eccentric-strap will form the eccentric-lever.

Each eccentric-lever will carry two mild-steel pins, one with a hardened steel thimble securely fastened.

One of these pins to engage with the radius-link and the other with the valve connecting-rod.

The movement of each valve is to be regulated by a reversing-arm and a radius-link.

Each reversing-arm is to be carried in bearings rising from the top of the corresponding crank-shaft bearing with its main centre line parallel to the axis of the crank-shaft, and in the same vertical plane. The reversing-arm with its journals to be of cast-steel. A forged-steel pin is to be secured in the free end of the arm to engage with the radius-link. Each radius-link is to engage at one end with this pin and at the other with the lower pin on the eccentric-lever.

Each valve-connecting-rod will engage at one end with the corresponding pin in the eccentric-lever and at the other end with a pin in an arm on the valve-motion rock-shaft of the low pressure, and direct with valve-stem of high and intermediate pressure cylinders.

The low-pressure valve-motion rock-shafts are to be carried in bearings bolted to the cylinder-casings, and are to have arms set at suitable inclinations to each other by which the motion will be transmitted to the valve-stems by links.

The radius-links, valve-connecting-rods, and valve-links are to be forged of mild steel, finished all over.

All joint-pins are to be of steel, hardened and ground to true circular cylindrical surfaces.

All working bearings are to be of phosphor-bronze or other composition.

The reversing-arm bearings are to be cast on the main pillow-blocks. The valve-motion rock-shafts and arms and reversing-arms are to be of cast-steel.

The radius-links are to be capable of adjustment so as to preserve a constant distance between centers when taking up lost motion.

Fixed trammels are to be furnished, suitably protected from injury, for setting the radius-link centers to their proper distances.

The valve-stems are to be marked and furnished with fixed trammels for setting the valves without removing the valve-chest bonnets.

A spare set of bearings is to be furnished for all adjustable joints.

All parts of the valve-gear are to be suitably marked for convenience of putting together properly when overhauling.

REVERSING-GEAR.

Each engine will have a steam reversing-gear with the cylinder placed horizontally. Each main-engine is to have one hand reversing-lever, which is to be conveniently placed to be worked from the working-platform. The reversing-lever sectors are to have adjustable stops to prevent the hand-levers being thrown beyond the full-ahead and astern positions.

The reversing-engines are to exhaust into the respective condensers.

STEAM-GOVERNOR.

There will be an efficient governor of an approved type, with all necessary connections fitted to the reversing-lever of each engine, so as to control the admission of steam to each cylinder for preventing racing in rough weather.

CYLINDER RELIEF-VALVES.

There will be an automatic relief-valve of not less than 3 inches diameter, located near the bottom of each cylinder; these valves to be guided by loosely fitting wings. They will be kept on their seats by the pressure of steam in their respective receivers, and by a light spiral spring. The design of this detail to be approved before its construction.

CYLINDER DRAIN-VALVES.

There will be fitted to each end of each cylinder, as low as possible, a drain-valve of approved design, with 1-inch opening. These valves to be made of composition and to be flanged and bolted to bosses on cylinder-casings or heads. They are to be arranged to work by hand-levers at working-platform if found necessary.

PISTONS.

The pistons will be made of steel, the thickness of metal to be $2\frac{1}{4}$ inches at center and $1\frac{3}{8}$ inches at periphery; that around the eyes of the piston-rods to be $1\frac{3}{8}$ inches. Each piston will have one cast-iron wearing-shoe upon which it will rest. These shoes to be so fitted that they can be adjusted to take the wear. The packing-rings are to be $\frac{3}{4}$ inch thick, $\frac{5}{8}$ inch wide, and will be adjusted by steel springs of proper tension. The followers are to be $1\frac{1}{2}$ inches thick, and secured in place by six steel bolts for the high, seven for the intermediate, and ten for the low-pressure pistons; all one inch diameter.

PISTON-RODS.

The piston-rods are to be of steel, finished $3\frac{3}{4}$ inches diameter, fitted and secured to the pistons by iron nuts. The piston-rods will be fitted into cross-heads and secured by nuts.

CYLINDER TIE-RODS.

The tie-rods securing the cylinders to pillow-block frames will be made of steel, turned to a diameter of 3½ inches. They will have T-heads forged on each end. These rods will be secured to the pillow-blocks and to the cylinders by steel bolts 2¼ inches diameter.

PISTON-ROD STUFFING-BOXES.

The piston-rod stuffing-boxes will be formed in the cylinder-heads, and will be fitted with cast-iron bushings and glands. They will be fitted with an approved metallic packing.

CROSS-HEADS.

The cross-heads are to be of steel, finished all over, and fitted with cast-steel slippers, lined with white metal, 12 inches wide, 13¼ inches long, and one inch thick. The connecting-rod journals are to be 4½ inches diameter and 5¼ inches long.

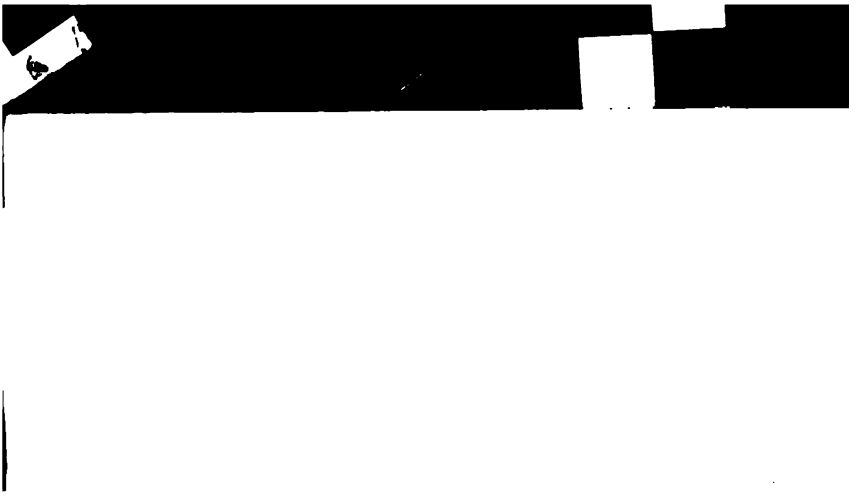
CROSS-HEAD SLIDES.

The cross-head slides will be made of steel, well secured to the cylinders at one end and to the bed-plate at the other.

CONNECTING RODS.

The connecting-rods are to be of wrought-iron, finished all over.

They will be 64 inches long between centers, 4½ inches diameter of neck at crank-pin end, and 3¾ inches diameter of neck at cross-head end. The crank-pin and cross-head boxes will be made of composition. The crank-pin boxes to be secured to rod by two 2¾-inch wrought-iron bolts, and each cross-head box by two 2¼-inch bolts; the nuts to be secured by proper set-screws. The boxes for crank-pins are to be 1¾ inches thick and for cross-heads 1 inch thick, accurately fitted to pins and rods.



CRANK-SHAFTS.

The crank-shaft for each set of engines will be made of steel, forged with solid webs and couplings, with cranks at equal angles. The shaft-journals will be 9 inches diameter and have a total length of about 68 inches.

The crank-webs will be 6½ inches thick. The crank-pins will be 9 inches diameter and 10 inches long.

The couplings will be 2½ inches thick and 18 inches diameter. The crank-pins and shaft-journals will have 3-inch holes axially through them.

All journals, when finished, will be tested and their accuracy proved.

CRANK-SHAFT BOXES AND CAPS.

Boxes of composition will be fitted to the main pedestals. The caps are to be of steel, and both boxes and caps are to be made with recesses for white-metal lining.

Each cap will have a hole through it of sufficient size to feel the journal. Each cap to be secured by two 2½-inch steel bolts, and with set-screws to prevent nuts from working loose.

Composition boxes to be hollow for water circulation. Both shaft and crank-pin brasses will be scraped to accurately fit their journals.

BED-PLATES AND PILLOW-BLOCKS.

The bed-plates for pillow-blocks will each be made in one casting, from which will spring the pedestals for crank-shaft bearings. The plates and pedestals will be cast hollow, with walls 1 inch thick, the metal around the boxes to be 1⅜ and 1¾ inches thick. The bottom flanges of bed-plates will be 1½ inches thick and 2¾ inches wide.

SURFACE-CONDENSERS.

The condenser-chests are to be cylindrical in form, "built up" of sheet-brass ¼ inch thick, amply sustained by angle and T-rings and composition flanges for the tube-plates.

The exhaust and discharge-nozzles, also the chambers for the circulating water and the covers for the same, are to be of composition as thin and light as practicable, combined with ample strength and stiffness. The diameter of the exhaust-opening will be 18 inches and of the discharge-openings to air-pumps 12 inches. The injection and delivery-openings for the circulating water will be 11 inches in diameter. All flanges to be not less than 2½ inches wide.

A ¾-inch salt-water feed-valve will be attached to each condenser.

Each chest will contain 2,151 seamless drawn brass tubes, ⅝ inch outside diameter, of No. 20 B. W. G. thickness, spaced $\frac{1}{16}\frac{5}{}$ of an inch between centers.

The exposed condensing length of tubes to be 7 feet, having a total cooling surface of 2,450 square feet. The tubes are to be thoroughly tinned inside and out previous to the last drawing.

The tube-plates are to be of brass, ¾ inch thick, stayed to heads by three ⅞-inch stays, bored or cored for the tubes, and counter-bored ⅞ inch diameter and $\frac{9}{16}$ inch deep, the packing to be compressed by composition glands screwed into the plates, and to have a device for preventing crawling of the tubes.

The tubes will be suitably supported by an approved system of composition diaphragm and deflecting plates in each condenser.

The condensers will be located behind the engine-cylinders and well secured in the ship.

Additionally the condenser in the forward compartment will be fitted with straightway-valves in its cylinder exhaust-pipe, and discharge-pipe close to air-pump, for closing all communication with the main engines when the condenser is used for auxiliary purposes. The openings of these valves to be equal to the area of their respective pipes.

AUXILIARY EXHAUST-MAIN.

The auxiliary exhaust-main, where it passes through the engine compartments, will have a diameter of 5 inches and will be made of copper. It will have in each engine compartment two exhaust-connections—one to condenser and one to low-pressure receiver, each 4 inches internal diameter. All flanges will be made of composition, faced not less than $2\frac{1}{2}$ inches wide.

AIR, CIRCULATING, AND BILGE-PUMPS.

Each engine will have a vertical single-acting air-pump, 24 inches diameter and 12 inches stroke; a single-acting circulating-pump, 20 inches diameter and 12 inches stroke; and two bilge-pumps, 4 inches diameter and 12 inches stroke, operated direct by a special compound engine.

The pump-cylinders, valve-chests, covers, bonnets, buckets, bucket-rods, plungers, valve-seats, and guards will be made of composition; the air-pump valves of hard rubber; the circulating and bilge-pump valves of rubber, with two layers of canvas. The pump-cylinders will be $\frac{7}{16}$ inch thick. All possible conveniences are to be attached to air and circulating-pumps for examination of valves.

CENTRIFUGAL BILGE-PUMP.

The centrifugal bilge-pump in forward engine compartment will be of approved design, capable of discharging with ease 800 gallons of water per minute against a head of 15 feet when using steam of 50 pounds pressure above the atmosphere. All pipes to be fitted with composition flanges of $2\frac{1}{2}$ inches face.

The pump will be operated by a special engine connected directly with it; will take steam from both main and auxiliary steam-pipes direct, and exhaust into the condenser through the auxiliary exhaust-main.

Pump-casing, fan, and pump-shaft to be of composition.

INJECTION-VALVES.

The chests, valves, seats, bonnets, glands, screw-stems, and hand-wheels of the injection-valves are to be of composition.

Each valve will have an opening through the seat of 10 inches diameter.

Each chest will have a nozzle of 3½ inches diameter of opening under the valve for fire-pump suction.

Composition strainers, equivalent in area to twice the area of valve, will cover the openings through the ship.

BILGE-INJECTION.

A copper pipe of 9 inches internal diameter will connect each main injection-valve chest with the bilge in its engine compartment. Each pipe will have attached to it a composition non-return valve of 9 inches diameter of opening.

OUTBOARD-DELIVERY VALVES.

The chests, bonnets, seats, valves, stems, and glands of outboard-delivery valves will be of composition.

The valves are to be fitted as checks, to open by pressure from inside, and faced with rubber to cover openings through seats 10 inches diameter. Each chest will have a valve of 3½ inches diameter of opening outside the main valve for the bilge-discharge from fire-pumps, and one for the discharge from main bilge-pumps.

SEA-VALVES.

There are to be two sea-valves of not less than 3½ inches diameter of opening in each fire-room, one to be used for blow and the other for sea suction.

The chests are to be provided with suitables nozzles for connecting them with pipes leading to boilers and pumps.

The chests, bonnets, valves, seats, stems, glands, and hand-wheels are to be made of composition.

The suctions are to have composition strainers, with holes through them of an aggregate area not less than twice the area of valve-openings.

FEED AND AUXILIARY PUMPS.

There are to be two vertical duplex-pumps of approved design, located in each fire-room; each pump to have water-cylinders of 4 inches diameter and a piston stroke of 7 inches. One pump in each fire-room to be connected to feed-tanks, bottom of forward condenser and boiler checks only, and to have a screw check-valve on both suction and delivery-pipes close to the pump. The other pump in each fire-room to be fitted to draw from feed-tank, sea, bilge, and boilers; and to deliver water into any of the boilers by a distinct set of feed-pipes and check-valves independent of the main feed system, and, likewise, into fire-main and overboard.

In addition, the forward auxiliary pump is to be fitted with a suitable discharge-pipe for flushing the head and for distilling purposes. It will discharge its water overboard through a sea-valve forward.

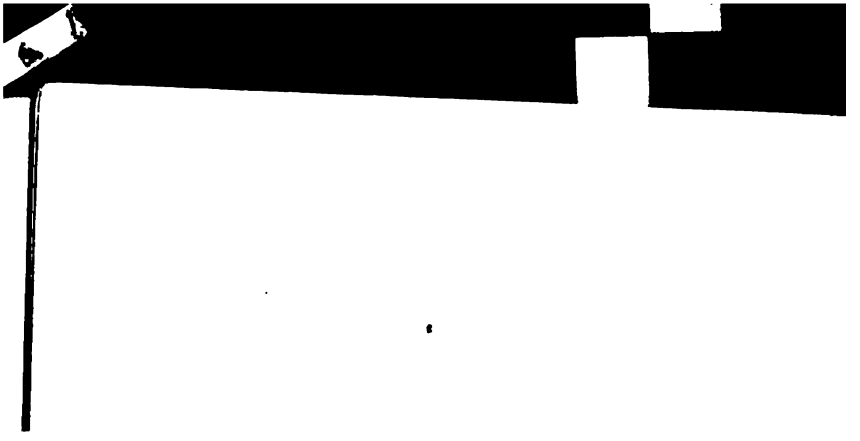
FIRE AND BILGE-PUMPS.

There will be a horizontal steam-pump of approved design placed in each engine-room. They will be fitted with the requisite valves and connections for use as bilge and fire-pumps, and draw water from the sea through a valve on main injection-chest or through bottom of ship and from the bilge. They will deliver overboard through valves on outboard-delivery valve-chests, and into fire-main.

Each pump will have a steam-cylinder of 8 inches diameter, water-cylinder of 5 inches diameter, and a stroke of 12 inches.

EVAPORATOR, DISTILLER AND PUMP.

The distilling apparatus will be located on the berth-deck where directed, and will consist of one evaporator and distiller of approved design capable of furnishing 2,000 gallons of potable water in 24 hours.



The auxiliary pump in fire-room will be used as a circulating-pump for the distiller. The pump for supplying the evaporator will have a capacity equal to a No. 0 Blake boiler feed-pump; will be connected on the suction side with the salt-water side of the distiller, and will discharge into the evaporator through a suitable check-valve.

The circulating water, after passing through the distiller, will go forward through a 2-inch copper-pipe for use in flushing the heads; a 2-inch copper bye-pass pipe, fitted with suitable valves, will connect the discharge of the pump used to circulate water through the distiller with the pipe leading forward to the head, for use when from any cause the distiller is shut off.

The evaporator will be felted and lagged, and will be fitted with a safety-valve, steam-gauge, glass water-gauge, salinometer-pot, and blow-valve; the pipes from the blow-valves to lead through ship's side, or to be connected to the bottom-blows in fire-room, as may be hereafter determined.

The distiller to be fitted with a filter and with the pipes necessary for running the distilled water into the fresh-water tanks.

The evaporator will take steam from the auxiliary steam-pipe and will be fitted with automatic trap and with drain-pipe leading to feed-tank, or as directed.

PUMP-CYLINDERS.

The water-cylinders of all steam-pumps will be made of composition.

All pumps will have screw check-valves in suction and delivery-pipes close to pump-chambers, and stop-valves in both steam and exhaust-pipes. All suction-pipes leading to bilge, excepting those from the circulating-pumps, are to be fitted with Macomb bilge-strainers. The steam-cylinders of all pumps blowers, and other auxiliary machinery will have their exhaust-nozzles connected to an exhaust-main, which will pass through engine and fire-rooms. This main will be con-

nected to both main condensers and to the second receivers of both engines, will also have a discharge into the atmosphere, and will be furnished with the necessary valves for governing the direction of the exhaust. Additionally, the main feed-pumps will be supplied with means of turning their exhaust steam into their feed suction-pipes.

WORKING-PLATFORMS.

Working-platforms of wrought-iron will be situated below the center of shaft, and on each side of the bulkhead, between the engines, convenient to which will be arranged all the handles, levers, and connections for operating the engines, with the counters, revolution indicators, clocks, steam, and vacuum-gauges in plain view.

Ladders will be provided as means of escape from engine-rooms when the water-tight doors are closed, and will be located on the bulkhead separating the engine compartments.

The engine-room stairway for ordinary use will be accessible from the berth-deck, through a door in engine-room hatch bulkhead, and will have its landing on the working-platform in the forward engine compartment. A door near this stairway will communicate with after engine compartment, and suitable footways will be arranged for access to the moving parts of the machinery, fitted, where required, with brass hand-rails and finished wrought-iron stanchions.

FEED-WATER TANKS.

A feed-water tank will be placed in each engine-room near the air-pump. These will be made of wrought-iron not over $\frac{3}{16}$ inch in thickness, and will have a capacity of about 150 gallons. Each tank will be fitted as a filter and be provided with a vapor-pipe, a float-valve for preventing access of air to feed-pump, an overflow pipe, and a glass gauge.

A pipe of ample capacity will connect the tanks with each other, and will be furnished with a stop-valve for making or closing communication between the tanks.

Each shaft will be covered with a water-tight composition casing $\frac{7}{16}$ inch thick, except where it rests in bearings, where it will be $\frac{3}{4}$ inch thick, finished on the outside, and extending from the inboard coupling of forward length to 1 inch within the hub of the propeller; thence each shaft will taper from $9\frac{3}{4}$ inches to 8 inches in a length of $20\frac{1}{2}$ inches, and be fitted with one steel key, and will have a thread turned on the end, and be fitted with a nut, suitably locked, for taking the backing-thrust.

SCREW-PROPELLERS.

The propellers are to be made of manganese bronze, about $10\frac{1}{2}$ feet diameter; to have adjustable blades of such form and pitch as may be required, and to turn outward in forward motion.

OUTSIDE AND STERN-PIPE BEARINGS.

The stern-pipes and outside bearings will have composition bushings divided in halves, and fitted with lignumvitæ staves, with the proper flanges for securing them in position.

The bearings in stuffing-boxes to be about 17 inches long, the outer ones about 32 inches, and those in hangers about 40 inches.

All lignumvitæ is to bear on end of grain.

STERN-PIPE STUFFING-BOXES.

The stuffing-boxes are to be made of composition, with a packing space 1 inch wide and 6 inches deep, fitted with followers made in two parts with a space of $1\frac{1}{2}$ inches between them, and properly secured in place by Tobin's metal bolts. Each stuffing-box will be placed wholly within the stern-pipe, properly secured, and made water-tight by suitable flanges on its inboard end.

THRUST-BLOCKS AND BEARINGS.

The thrust-blocks and caps are to be of cast-iron, lined with white metal, and made for a circulation of water through them. They will be provided with stuffing-boxes and glands at both ends for retaining the oil.

The caps are to be made with lugs locking into the blocks, and will have ample oil and grease-cups with hinged covers.

Each cap will be well secured in place by four wrought-iron bolts 1¼ inches diameter.

The blocks will rest on sole-plates riveted to the foundations built in the ship, to which they will be secured by eight bolts 1¼ inches diameter, and fitted with keys so that they can be accurately adjusted to line in any direction.

SPRING-BEARING.

The line-shafting of forward engine, where it passes through after engine compartment, will be supported from the center-engine keelson by a spring-bearing having a length of at least 12 inches.

TURNING-GEAR.

A suitable gear is to be provided for turning the main engines.

FRICTION-BRAKE.

Steel friction-bands 2½ inches wide, with all the requisite connections, are to be fitted to clamp the circumference of one of the couplings of the shaft of each engine.

WATER-PIPES.

Seamless brass water-pipes 2½ inches diameter are to be fitted, and have two connections, one with the sea and one with discharge of auxiliary pump, with the necessary valves in each engine-room.

They will have two branches of not less than 1¼ inches diameter to each main and crank-pin bearing, one branch of 1 inch diameter to each eccentric, and two branches 1¼ inches diameter to each thrust-bearing.

Also two of ¾ inch diameter, screwed into each crank-shaft pillow-block, with holes leading down through brasses to tops of journals, and one of ¾ inch diameter screwed into each cross-head slide.

All branch water-pipes will be fitted with cocks or valves for regulating the supply of water to bearings.

JOURNAL-BOXES.

All journals or moving parts of iron or steel are to run in boxes either of composition, or of cast-iron or steel lined with white metal.

The crank-pin and crank-shaft boxes are to be lined with Parson's white metal.

INDICATOR FITTINGS AND MOTIONS.

Indicator-connections for each end of each steam-cylinder and air-pump are to be fitted, as near as possible, to the bores of their cylinders, and so located as to be easily accessible.

The indicator-motions are to be so designated as to give the indicator-barrels motions coincident with those of the pistons, and of sufficient throw to give a diagram of 4 inches length.

REVOLUTION-INDICATORS.

Revolution-indicators, showing on suitable dials the speed and direction of the engines, are to be placed in each engine-room, and suitable dials for showing in which direction the engines are turning are to be placed in such part of the ship, on deck, as may be required.

OIL-CUPS.

Each crank-pin will be fitted with a centrifugal oiling device as well as a telescopic or wiping arrangement, both to be of approved design. All crank-shaft bearings will have an-

ple oil-cups with hinged covers, tube and wick-holders, and so arranged that the amount of oil passing down each tube to the journals can be seen and regulated. Wipers carried by the upper ends of the eccentric-levers are to furnish oil for lubricating the eccentrics and all connections of the eccentric-levers. These wipers to take oil from strips of webbing or other approved device, supplied by oil-cups suitably supported and capable of adjustment so as to feed oil in all positions of the valve-gear, and also so arranged as to make the supply of oil to the various parts independently adjustable.

All other joints or moving parts not otherwise referred to, and especially the cross-head slides and the valve-connections, are to have finished brass automatic oiling-gear of approved design, capable of supplying sufficient lubrication while the engines are in operation without waste of oil.

All oil-cups to be such as can be easily filled while the engines are running at maximum speed, and to have an oil capacity for at least four hours running.

All fixed bearings to have drip-cups cast on where possible, otherwise to be made of cast-brass and properly fitted.

All such cups to have drain-pipes and cocks of at least ½ inch diameter, which can be used while the engines are in operation.

All moving bearings are to have drip-cups or pans of sheet-brass where necessary.

HOLES THROUGH SHIP.

All holes through the ship are to be covered by cocks or valves on the inside, and to be fitted with zinc protecting-rings if required.

PUMP-CONNECTIONS TO FIRE-MAIN.

The fire and auxiliary feed-pumps will each have a discharge-pipe, with straightway stop-valve, connecting it with the fire-main running fore and aft, and a branch from each discharge-pipe near the pump will be fitted with standard hose-connections and straightway-valve.

EYE-BOLTS.

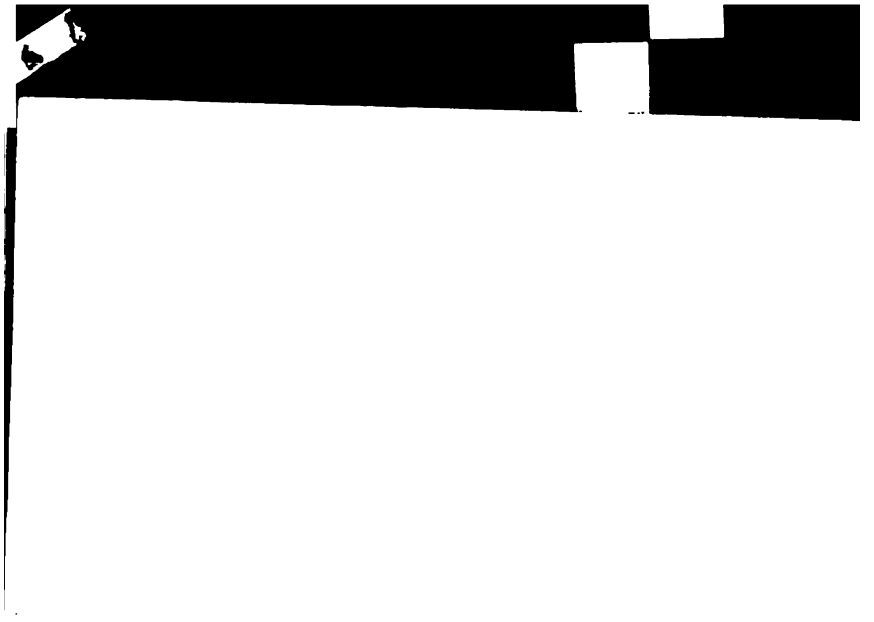
Wrought-iron eye-bolts and traveler-bars are to be properly located and secured wherever required for lifting different parts of machinery, and particularly the covers of cylinders and valve-chests, the covers of air and circulating-pumps and their valve-chests, the condenser-bonnets, the connecting-rods, the caps of pillow-blocks of crank-shaft and line-shaft journals and of thrust-bearings.

SECURING ENGINES IN SHIP.

The engines will be adjusted and lined upon the engine-keelsons, and when accurately in line the spaces around holding-down bolts between sole-plates and keelsons will be filled by accurately fitting wrought-iron washers, upon which the holding-down bolts will be set up and locked in place.

STEERING-ENGINE.

A steering-engine of the Williamson type will be supplied and fitted where shown on the plans. It will be of the latest type to work by hand or steam-power, and of sufficient power to put the rudder from amidships to hard-over in 12 seconds when the vessel is going ahead at the rate of 16 knots per hour. The engine contractors will fit and secure the engine, supply the steering-wheels directly attached to it, make the steam and exhaust-connections, and supply and fit the whole main-shaft and sprocket-wheel; but all deck-wheels, and all rods and gear for actuating the valves from the deck are to be fitted by the hull contractors, who will also cut all holes in the decks and bulkheads for securing the engine and running the shaft, &c. Where the shaft passes through bulkheads, brass stuffing-boxes will be fitted water-tight. All journals are to be in brass bearings and fitted with self-feeding oil-cups.



STEAM-WINDLASS AND CAPSTAN.

A steam-windlass of approved pattern, suitable for 1⅛-inch chain, will be supplied and fitted. It will be located on the main deck under the forecastle, where shown on the plans of the hull, and will have a capstan attachment on the deck above. Both capstan and windlass to work by either hand or steam-power. The steam-cylinders, which must be of sufficient size to raise both anchors at once at the rate of 6 fathoms per minute, with steam-pressure of 30 pounds by gauge, must have reversing-gear, and be located upon the main deck. Steam and exhaust-connections will be made and all fittings, capstan-bars, and spare parts supplied complete.

The contractors for the hull will make all holes in the decks for securing the windlass and capstan, and will stow the fittings, &c.

DRAIN-PIPES AND TRAPS.

All receptacles where condensed steam is likely to accumulate will be provided with drain-pipes and cocks of ample capacity leading to automatic traps (fitted with bye-pass pipes and valves), which will discharge into feed-tanks.

The drain-pipes from safety-valves are to be connected at least ½ inch below the level of valve-seats.

BOILERS AND ATTACHMENTS.

There are to be four horizontal tubular boilers placed forward of the engines, in pairs longitudinally, one pair forward and one pair abaft an athwart-ship bulkhead passing under the center of the smoke-pipe. The boilers are to carry a working pressure of 160 pounds by gauge. There will be two athwart-ship fire-rooms, one forward of the forward boilers and one abaft the after boilers.

There is to be one fixed smoke-pipe in vertical plane over the keel, connecting with an uptake common to the four boilers. The boilers are to be constructed of open-hearth steel.

All plates are to be planed on their edges, and thoroughly calked inside and out wherever accessible. Butt-jointed seams are to be covered with straps, and all rivet-holes are to be drilled to full size. Each boiler is to be 9 feet 9 inches mean diameter outside and about 17 feet 6 inches long, and to have three furnaces 37 inches least internal diameter, projecting about 3½ inches from the front of boiler and extending to combustion-chamber.

GRATE-SURFACE.

Each furnace is to have a grate 69 inches long, or 18.4 feet in area, aggregating 220 square feet in the four boilers.

GRATE-BARS.

The grate-bars to be of wrought-iron, in two lengths, of approved pattern. The furnace-fronts, bridge-walls, and bearers to be properly fitted to support the bars.

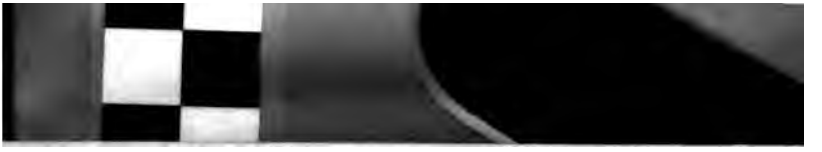
TUBES.

Each boiler is to contain about four hundred and thirty lap-welded wrought-iron tubes. Every third tube, vertically and horizontally, is to be a stay-tube, and will be No. 6 B. W. G. thick and 2¼ or 2½ inches external diameter. The other tubes will be No. 11 B. W. G. in thickness, 2¼ or 2½ inches external diameter.

The stay-tubes will be screwed into both heads, the back ends to be swelled and fitted with a nut on the outside of head. This method of setting is subject to change if so directed.

BOILER-SHELLS.

The shells are to be of plates $\frac{3}{8}$ inch thick, the longitudinal joints to be double-strapped and double-riveted each side of seams. The circular joints to be lap-jointed and double-riveted.



TUBE-SHEETS.

The tube-sheets are to be $\frac{9}{16}$ inch in thickness, and are to be accurately drilled for the tubes.

BOILER-HEADS AND BRACES.

The upper portion of the heads are to be $\frac{3}{4}$ inch thick and the lower portions $\frac{9}{16}$ inch thick. The upper portions of heads will be braced by three rows of steel stays $2\frac{1}{2}$ inches diameter in the body, 15 inches between centers horizontally and 12 inches vertically. There will be one $2\frac{1}{2}$-inch, two 2-inch, and six $1\frac{3}{4}$-inch iron braces between front head and combustion-chamber, and two $1\frac{3}{4}$-inch iron braces between back head and combustion-chamber. The tops of combustion-chambers to be stayed to shell by $1\frac{1}{8}$-inch iron braces with crow-feet on top of the chambers, placed $6\frac{3}{4}$ inches apart in length of boiler, and 15 inches in the diameter. All steel braces to be without welds in length or eyes. The through braces will be made with nuts on both sides of boiler-heads, having raised threads on ends.

FURNACES.

The furnaces are to be of the best steel, welded at joints, and corrugated. They are to be 37 inches diameter at the inside of corrugation, $\frac{1}{2}$ inch thick, and are to be single-riveted at their junctions with front heads and combustion-chambers. Ash-pans of $\frac{1}{4}$-inch wrought-iron will be fitted in all furnace-flues reaching from front to bridge-wall.

BRIDGE-WALLS.

A bridge-wall of approved pattern will be fitted in each furnace. The upper part will be finished with fire-brick. The lower part, below the grate-bars, to be furnished with a hinged door at least 6 inches high and as wide as possible, so made as to be easily opened and shut from fire-room. The bridge-walls to be easily removable.

COMBUSTION-CHAMBERS.

The combustion-chambers are to be about 42 inches deep; the sides, tops, ends, furnace-plates, and tube-sheets to be $\frac{9}{16}$ inch thick. The sides to be stayed by steel screw stay-bolts $1\frac{1}{4}$ inches least diameter, spaced not over $7\frac{1}{2}$ inches from center to center.

BACK CONNECTIONS AND UPTAKES.

The back connections and uptakes are to be made with single shell, covered with an approved non-conducting substance and protected by an outside shell. The inner shell to be secured to boilers by $2\frac{1}{2}$-inch angle-irons; angle-irons elsewhere to be 2 inches. Both shells to be made of iron weighing, respectively, 6 pounds and 4 pounds per square foot.

The uptakes of each pair of boilers will pass upwards independently to the height of the water-tight bulkhead, across which they will be united. They will also be so divided that the gases from each boiler will have a separate passage to its own compartment of the smoke-pipe.

The connection doors are to be made of wrought-iron with double shells, and fitted with hinges and catches of wrought or malleable iron. The outside shell is to be $\frac{3}{16}$ inch thick and the lining $\frac{1}{8}$ inch thick. The outer shell to be flanged 1 inch deep, and the inner one $2\frac{1}{4}$ inches deep.

FURNACE FRONTS.

The furnace fronts are to be made of wrought-iron plates $\frac{1}{4}$ inch thick on the inside and $\frac{3}{8}$ inch thick on the outside; both plates to be suitably perforated for air-entry, if so directed.

FURNACE-DOORS.

The furnace-doors are to be of wrought-iron $\frac{1}{4}$ inch thick and flanged 1 inch deep; each to be fitted with a perforated wrought-iron inner-plate, and provided with wrought-iron hinges, air-regulators, and catches.

weight. The pipe will have fore-and-aft and athwart-ship partitions running from bottom to top. A pivoted damper will be fitted in each compartment of the pipe, near the top; to serve also as a cover. Drain-troughs to be fitted below the dampers so as to catch all water passing them when closed, with drain-pipes leading where directed. Each damper to be worked from the fire-room, containing the boiler which it controls, by approved mechanism. A permanent ladder reaching to the top of smoke-pipe will be fitted as directed.

DRY-PIPES.

Each boiler is to have a properly perforated tinned brass dry-pipe of reduced diameter at the internal end, but of same diameter at front end as the steam-pipe with which it is connected. It is to be placed as high as possible, and extend nearly the length of the boiler.

Its upper surface is to be pierced with holes $\frac{3}{8}$ inch in diameter spaced equidistant, their aggregate area to be twice that of the cross-section of the pipe.

BOILER-CLOTHING.

After the boilers are in place in the vessel and have been tested under steam, their shells and fronts are to be covered with approved material, which will be protected by a galvanized-iron covering, the joints of which will be lapped and bolted. The iron is to be painted with two coats of brown zinc paint.

SAFETY-VALVES.

Each boiler is to have an automatic spring safety-valve, 5 inches in diameter, adapted to a maximum pressure of 160 pounds per gauge, and fitted with proper levers and approved mechanism for working them from the fire-rooms. The chests, valves, and stems are to be of composition, and the seats of nickel.

The chests are to be bolted to the stop-valve chambers, if possible, and connected by copper pipes to the escape-pipes, which will also be of copper. The seats of all safety-valves will be at least ½ inch above the bottom of their chests.

SENTINEL-VALVES.

There is to be a sentinel-valve of ½ square inch area attached to the front of each boiler, fitted with movable weight and notched lever, and weighted to close tightly against a boiler-pressure of 240 pounds per square inch.

STEAM-WHISTLE.

A composition steam-whistle, the bell of 6 inches diameter, is to be placed forward of the smoke-pipe, well above the level of the deck-awning, and connected with the main steam-pipe by a copper pipe having at its lower end a valve of appropriate kind and size, and a working-valve at upper end.

WATER-GAUGES.

Each boiler is to have on its front two composition water-gauges carrying glasses 16 inches in exposed length, and with outside pipe-connections to top and bottom of boiler, the bottom of glass being 1 inch below the highest heating surface.

There shall also be four gauge-cocks placed 4 inches apart, the lowest cock to be placed 4 inches below the highest heating surface of the boiler. The cocks will be supplied with drip-pans and drain-pipes.

SALINOMETER POTS.

There is to be a salinometer pot of approved pattern for each boiler, fitted in an accessible position and suitably connected.

BOILER-TEST.

Before being placed in the vessel, all the boilers are to be tested under a pressure of 240 pounds by gauge. This pressure to be obtained by the application of heat to water within the boilers, which are to be filled quite full. After a satisfactory test, the boilers are to be painted on outside with two coats of brown zinc paint.

AUXILIARY STEAM-PIPES AND VALVES.

Each boiler stop-valve chamber will have an auxiliary stop-valve 3½ inches diameter bolted to the nozzle on its side and under the main-valve. These valves are to be connected by an auxiliary steam-pipe of 3½ inches internal diameter, with suitable branches leading to the pumps, heaters, distiller, evaporator, and auxiliary engines.

A branch-pipe with stop-valve will connect main and auxiliary steam-pipes in each engine-room.

A steam-guage in brass case, with 6-inch dial, will be attached to the auxiliary steam-pipe in each engine-room and each fire-room; also at windlass and steering-engine.

BLEEDER.

There is to be a copper pipe, with stop-valve at each end, 3½ inches in diameter, leading from the main steam-pipe to each condenser. One valve in each engine-room to be worked from working-platform.

CHECK-VALVES.

Each boiler is to have two feed check-valves, 2 inches in diameter, having outside screw-threads on their stems; chambers, valves, and stems to be made of composition.

All check-valves to have internal pipes.

BLOW-VALVES.

Each boiler is to have a bottom blow-valve of composition $2\frac{1}{2}$ inches in diameter; also a surface blow-valve $1\frac{1}{2}$ inches in diameter. These valves are to be connected by suitable pipes to the sea-valves.

The bottom blow-valves are to have internal pipes leading toward the bottoms of boilers, the surface blow-valves to have pipes leading to the centers of boilers, with openings about 1 inch above the highest heating surface.

FEED AND BLOW-PIPES.

The main feed-pipes are to be made of copper or seamless drawn brass tubes, 2 inches in internal diameter, and in sections not exceeding 12 feet in length. The blow-pipes to be $2\frac{1}{2}$ inches in diameter. The branches to be of copper or brass, as may be directed. All elbows, nozzles, turns, and flanges are to be of composition. The several sections are to be expanded into flanges, then turned over and brazed. All flanges to be united by forged bolts and nuts of Tobin's metal. Suitable provision will be made for the expansion of these pipes.

BOILER STOP-VALVES.

Each boiler is to have a composition stop-valve chamber. The valve to be 6 inches in diameter, fitted with a screw-stem of composition, made to turn independently of the valve, and to work in a composition nut supported by wrought-iron studs screwed into the cover. The valve is to be operated by a composition hand-wheel 12 inches in diameter. Separate provision is to be made for working all boiler stop-valves from above the protective deck.

MAIN STEAM-PIPES.

The steam-pipes at stop-valves are to be 6 inches in internal diameter. The forward pair of boilers will be connected by a separate 8-inch pipe to forward engines, the after pair by an

8-inch pipe to after engines, these two pipes to be connected by an 8-inch pipe in after fire-room. These pipes are to be of copper, the several sections to be united to each other and to the separators and valve-chambers by composition flanges of suitable size and thickness, riveted on and properly brazed. Where these pipes pass through water-tight bulkheads they are to be provided with approved provision for expansion.

The steam-pipes and flanges to be covered with an approved non-conducting material, which will be covered and protected by an approved water-tight covering, this covering to be secured to bulkheads where the pipes pass through them.

ESCAPE-PIPES.

There will be two escape-pipes of copper, one forward and one abaft the smoke-pipe, extending to the top of the pipe and secured to it.

PIPE-CLOTHING.

All main and auxiliary steam-pipes, exhaust-pipes where directed, the separator, and all steam-valves, are to be clothed with an approved non-conducting material, covered with canvas in double thickness, well painted. The covering to be secured to bulkheads where the pipes pass through them. The pipes are also to be covered with black walnut lagging with brass bands where directed.

PIPES THROUGH BULKHEADS.

All pipes where they pass through water-tight bulkheads will be provided with stuffing-boxes, or made tight in other approved manner.

BOILER DRAIN-COCKS.

There will be a drain-cock having $1\frac{1}{2}$ inches diameter of opening, fitted to each end of each boiler.

SEPARATORS.

There is to be a separator in each main steam-pipe of approved kind; it will be fitted with an automatic trap, a drain-pipe and valve leading to feed-tank, and a glass water-gauge on the side.

FLOOR-PLATES.

The fire and engine-rooms and their passages are to be floored with wrought-iron plates having corrugations on the upper surface and proper ledges and drain-holes. They are to be of wrought-iron not less than $\frac{1}{4}$ inch thick, and all easily removable.

BLOWERS.

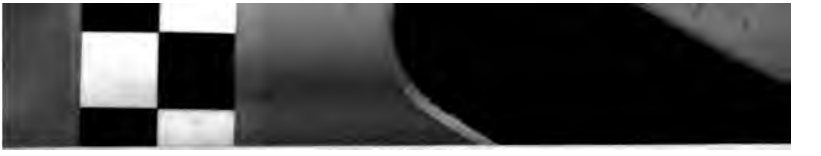
The fire-rooms are to be supplied with air by means of blowers, two to each fire-room. Each blower is to be driven by its own engines direct, and to be capable of supplying, with ease and certainty, sufficient air for efficient forced draught. One of the after-blowers is to be fitted to take its air from the engine-rooms as well as from deck.

Each fire-room ventilator is to be so fitted that it can be easily closed from fire-room in case its blower is stopped.

VENTILATORS.

Four ventilators, each 24 inches in diameter, are to be fitted, two in each fire-room. They are to deliver air to the inlet of the blowers placed under them. They are to have movable hoods, and will be made of iron $\frac{1}{8}$ inch thick above the spar-deck, and of iron No. 11 B. W. G. below it. The gears for turning the hoods will be of composition. Additionally, there will be in the corners of the boiler-hatch four ventilators, placed outside of the pipe-jacket; they will be 21 inches in diameter inside, made with movable hoods worked from deck. They will discharge the air downward through the grating of the hatch, and beneath the protective-deck will be arranged to deflect the air outward.

Four ventilators, 18 inches diameter, are to be fitted—two to each engine-room; they will lead down the engine-room



hatches, or as directed; their cowls will be worked from the engine-rooms. All ventilator-cowls will be made of copper No. 12 B. W. G., unplanished.

ASH-HOISTS.

There will be an ash-hoist arranged in ventilators for each fire-room. They are to be fitted with appropriate appliances for sustaining the upper block of the ash-whip, and a means for closing them when an air-pressure is required in the fire-room.

There will be an approved ash-hoisting engine for each fire-room, to hoist 150 pounds from fire-room floor to deck in five seconds with 20 pounds steam-pressure. They will be fitted with all necessary connections, including whip, and with a suitable brake to control the drum.

From each ash-hoist, on the upper deck, permanent overhead rails, suitably supported, will lead to the nearest ash-chute on each side of ship. Each of these will be fitted with a traveler of approved design, with all necessary appliances for carrying the ash-buckets. At the top of each ash-chute a dumping-hopper will be fitted, so arranged as to fold up out of the way when not in use. The ash-buckets are to be balanced dump-buckets with gear complete. All of the ash-hoisting and dumping-gear is to be such that the buckets will not have to be lifted by hand. A speaking-tube will lead from the top of each ash-hoist to fire-room.

AIR-TIGHT FIRE-ROOMS.

Supplementary bulkheads and ceilings of light galvanized iron are to be fitted in the fire-rooms for the purpose of reducing the capacity of the space to be put under air-pressure. The ceiling is to be made movable beneath hatches. The vertical portion to be provided with openings where passage-ways are required, with suitable means for closing them.

All permanent and temporary joints and seams to be made perfectly air-tight.

HYDROKINETER.

There will be connected to each boiler a Weir's hydrokineter, or other approved appliance for circulating water in the boiler while raising steam, proper connections being made to auxiliary steam-pipe.

TESTS OF MATERIAL.

All material used in the construction of the boilers, crank-shafts, line, thrust, and propeller-shafting, will be tested in accordance with the "Instructions to Inspectors," a copy of which is appended to these specifications.

DUPLICATE PIECES.

All duplicate pieces are to be finished and fitted ready for use. They are to be as follows, viz:

One set of valves and springs for each steam-pump.

One seat, with guards and bolts complete, for receiving-valves, and one for delivery-valves of air-pump.

One-half set of follower-bolts and nuts for each steam-piston, and one-half set for each air-pump piston.

One set of brasses for each crank-shaft journal of each engine.

One set of brasses for each crank-pin and cross-head journal of each engine.

One slipper for each cross-head.

One set of brasses for each adjustable connection of each valve-gear.

Three extra blades will be furnished for each screw-propeller, to be of such dimensions as may be required.

Two hundred condenser-tubes packed in boxes.

Forty stay-tubes, threaded to fit threads in tube-sheets, and 100 plain boiler-tubes, annealed. The ends of stay-tubes to be wrapped in canvas. All boiler-tubes to be securely stowed in racks or as directed.

Forty stay-tube nuts.

One spare basket for each Macomb's strainer.

One-eighth of a set of grate-bars.

All duplicate pieces not of brass to be painted with three coats of white lead and oil, and well lashed in tarred canvas, with name marked in black paint on the outside.

Brass pieces to be marked or stamped.

OIL-TANKS, CANS, ETC.

Four oil-tanks of iron $\frac{1}{8}$ of an inch thick, with an aggregate capacity of 500 gallons, are to be well secured in oil store-room, with facilities for filling them from deck. The tanks are to be strengthened by internal stays, if directed. Each tank will have a man-hole near the top closed by a plate, and will be fitted with a locked cock for drawing oil.

Four copper oil-tanks of 10 gallons capacity each, with lids and drip-pans, to be placed permanently in the engine-rooms, in convenient positions, and to have a locked brass cock on each.

A copper oil-tank of 5 gallons capacity, with drip-pan, will be fitted in each fire-room.

An iron tallow-tank of 100 pounds capacity, with hinged cover, will be fitted in one engine-room.

INSTRUMENTS, TOOLS, ETC.

Twelve indicators of standard size and approved pattern, with proper attachments of finished brass, are to be furnished ready fitted; each indicator will be fitted with three springs graduated respectively to a scale of 80, 40, and 16 pounds to the inch, and with an extra cock-attachment. A separate indicator stand-pipe is to be connected to each end of each main cylinder, by a pipe one inch diameter, having a cock of equal area of opening.

Two sets of instruments, with proper attachments, each instrument in its own case, which will be of brass, as follows, viz:

Two Lane's improved spring steam-gauges, 6-inch face.

One Lane's improved spring compound-gauge, 6-inch face.

One Lane's improved spring vacuum-gauge, 6-inch face.

One continuous counter, with positive motion, to register from 1 to 1,000,000.

One eight-day clock with second-hand.

One mercurial vacuum-gauge attached immediately to condenser.

The above list to be considered as one set.

There will be four Lane's improved spring-gauges, one for each boiler, with $8\frac{1}{2}$-inch face, and graduated to 320 pounds.

Each gauge will be properly secured in the fire-room and have an independent connection to its boiler.

Eight thermometers, one for each hot-well or feed-tank, one in each outboard delivery-pipe, one for each injection, and one for each steam-pipe close to the engines, to be made permanent fixtures, with their stems and bulbs protected by brass covers; also two spare steam-thermometers, two spare water-thermometers, and one standardized thermometer in suitable case.

An engine-room telegraph of approved design, with reply-gongs and any number of dials that may be required, to be supplied and fitted for each pair of engines. Telegraphs of approved pattern are to be fitted to put engine-rooms and fire-rooms in communication.

A gauge of approved pattern will be fitted in each fire-room to show the excess of air-pressure over the pressure of the open atmosphere. A portable air-pressure gauge will also be supplied to each fire-room, with connections for attaching it to the furnaces, uptakes, and where directed, to measure the pressure as compared with the air-pressure in the fire-room. All of these gauges to indicate pressures in "inches of water."

A set of wrenches fitting all nuts in fire-rooms is to be supplied to each fire-room, and placed in iron racks.

Fixed trammels or gauges are to be supplied for lining up crank-shafts horizontally and vertically, marks for this purpose being made on brass plates let into pillow-block frames.

Two complete sets of fire-irons for each fire-room, with suitable racks for stowing.

Lazy-bars for each boiler to be fitted in place.

One set of wrenches complete for each engine, to be fitted to all the nuts, finished and marked with size, and placed in iron

racks. Wrenches for all nuts of bolts two inches in diameter and over to be box-wrenches, where such can be used.

One pair of taps, on rod, for tapping front and back tube-sheets at one operation. This to be a duplicate of the tool used in originally tapping the sheets, and to be packed so as to be perfectly protected from injury.

A steam tube-cleaner of approved design with fittings and connections complete. To be of sufficient length to clean the tubes from the fire-room end through furnaces or ash-pits. To be fitted with a wooden handle and stowed in a convenient rack in fire-room. A spare nozzle and flexible steam-pipe to be furnished.

Twelve ash-buckets.

Twelve coal-buckets.

SCHEDULE OF THICKNESS OF COPPER AND BRASS PIPES, B. W. G.

	Number.
Main and branch steam-pipes: 8″	5
6″	7
4″	9
3″	11
Air-pump discharge	12
Circulating suction and discharge	10
Bilge-suction and delivery, large pump	12
Blow-pipes	12
Main exhaust	10
Auxiliary steam-pipes	8
Main and auxiliary feed-delivery	12
Main and auxiliary feed-suction	14
Waste steam-pipes and auxiliary exhausts	16
Dry pipes	14

All bends are to be made one gauge thicker than straight part of pipe. All tee-pieces for brass pipes to be of composition.

Expansion-joints or bends are to be fitted to pipes wherever required.

AUXILIARY EXHAUST TO ESCAPE-PIPES.

Where the auxiliary exhaust main is connected to the escape-pipes it will have two stop-valves, close together, for each connection.

ASH-SPRINKLERS.

There will be on athwart-ship bulkheads of fire-rooms, opposite each boiler, about four feet from floor, a brass nozzle with universal joint, with valve and sea connection for wetting ashes. This to be of approved design and to be secured alongside bulkhead when not in use.

MANDRELS FOR WHITE-METAL BEARINGS.

Cast-iron mandrels are to be furnished for forming the linings of all bearings lined with white metal. All these to be smoothly and accurately turned, and to be packed so as to be perfectly protected.

RADIATORS.

Steam radiators of the following numbers and superficial area for the several parts of the ship will be provided, viz:

For the cabin 5, aggregating 90 square feet.

For the ward-room 2, aggregating 40 square feet.

For the steerage-country 3, aggregating 46 square feet.

For the berth-deck 3, aggregating 80 square feet.

For the wheel-house 1, of 4 square feet.

For the executive officer's office 1, of 2 square feet.

Under the forecastle 1 or more, aggregating 90 square feet.

Each radiator will be divided into as many separate and distinct parts as may be directed; each part to have its own steam and drain-valve. The steam and drain-pipes are to be seamless drawn brass, of iron-pipe size, suitably connected by composition elbows, tees, and unions in a manner that will enable them to be easily taken down for repairs.

There will be reducing-valves in these pipes at the boiler connections to regulate the pressure, and the drains will lead to such water-collectors as may be designated, or where preferred, overboard.

MATERIALS AND WORKMANSHIP.

All materials used in the construction of the machinery are to be of the best quality. The iron castings to be of the best pig-iron (not scrap). The brass castings to be made of new materials of best quality. Where Tobin's metal is specified, the composition to be 58.22 parts copper, 39.48 parts zinc, 2.30 parts tin. For all other brass-work the composition to be 88 parts copper, 10 parts tin, and 2 parts zinc. All iron castings to be smooth and true to form, and before being painted to be well cleansed of sand and scale, and all fins and roughness removed.

All boiler-plates to be thoroughly cleansed of oxide-of-iron scale. Brass castings to be sound, smooth, and true. No imperfect casting or unsound forging will be used if the imperfection affects the strength, or, to a marked degree, its sightliness.

All flanged boiler-plates are to be annealed in an approved manner after flanging.

The steam-cylinders of all auxiliary engines are to be clothed and lagged the same as main cylinders

All cocks are to have engraved brass plates to show their use and whether open or shut. All valve-wheels will be of composition, and will be plainly engraved to show their use, as will also all working levers and all gear for working valves from deck.

All steam, exhaust, and other pipes leading to and from steering and other engines, distillers, and pumps are to be of sufficient size for their respective objects, and to have provision for expansion where directed.

All copper pipes not seamless drawn are to be brazed, and all copper pipes are to be expanded into composition flanges, turned over and brazed.

All pipes passing through coal-bunkers will be cased in.

All pipes, not otherwise specified, to be of copper, and all pipes beneath floor-plates to be connected by forged bolts and nuts of Tobin's metal. All nuts on rough castings to fit facings.

All pipes beneath floor-plates to be covered as directed, and care taken that they do not come in contact with the plates or frames of hull.

The work to be in every respect of the first quality, and executed in a workmanlike and substantial manner.

All flanges to be faced and grooved. All bolt-holes in permanently fixed parts to be reamed, and the body of the bolts to be finished to fit them snugly. All threads on bolts to correspond to the Navy standard. All brasses to fit loosely between collars of shafting.

All nuts on moving parts and on pillow-blocks to be thoroughly secured with keepers, pins, or steel set-screws. All brasses or journals to be properly channeled for the proper distribution of oil. All flanges coupled together to be faced, and edges made fair with each other. Metallic packing for stuffing-boxes to be such as may be approved.

The cylinder-casings, condensers, and all tubes and pipes are to be tested for tightness before being placed in the ship.

All engine-work not finished to be primed with two coats of brown zinc and oil, and when placed in position on board the vessel will be painted with two coats of paint of approved color.

The line-shafting is to be painted when in place with two coats of white-lead and oil, and the boiler fronts with two coats of lamp-black and oil. The smoke-pipe is to be thoroughly painted both before and after its erection on board the vessel.

All steam-pipes not lagged will be painted white, exhaust-pipes green, water-supply pipes red, and water-discharge pipes lead-color.

All materials and parts of the machinery shall be carefully weighed by the contractor, when ready to go on board the vessel, and a record of the weights in detail furnished to the Inspector, certified to by him, and reported to the Bureau of Steam Engineering.

While the engines and boilers are being completed, steam shall be raised in the boilers whenever required to test the connections, the working of all parts of the main engines and boilers, and all auxiliaries. All expense of such preliminary tests will be borne by the contractor.

Any portion of the work, whether partially or entirely completed, found defective, must be removed and satisfactorily replaced without extra charge.

All drawings necessary during the progress of the work must be prepared by and at the expense of the contractor.

All plans involving changes or modifications of the original drawings must be approved.

A complete set of drawings of the machinery as fitted must be furnished by the contractor, certified to by the Inspector of Machinery, and forwarded to the Bureau of Steam Engineering immediately upon completion of the work.

A suitable office and draughting-room, properly fitted and heated, for the use of the Inspector of Machinery and his assistants during the building of the machinery, is to be furnished by the contractor.

The contractors for the hull will supply the labor to fit the engine and boiler-keelsons to the engines and boilers, and similarly for all auxiliaries.

All parts of machinery and boilers are to be secured, in an approved manner, to prevent displacement when the vessel is used for ramming.

The engines, boilers, uptakes, and smoke-pipe, all auxiliaries, their piping and connections, and all sea-valves, except the cutting of the holes for the same, and all parts described in these specifications and official drawings, are to be fitted complete to the ship by the engine contractors; and any part of the machinery or any article pertaining thereto which may have been inadvertently omitted from these specifications or from the official drawings, but which is necessary for the proper completion of the vessel, is to be supplied by the contractor without extra charge.

TESTS OF STEEL FOR CRUISERS.

INSTRUCTIONS TO INSPECTORS.

The following rules are prescribed in order to insure the fulfillment of the clause of the Act of Congress of August 5, 1882: "Such vessels * * * to be constructed of steel of domestic manufacture, having as near as may be a tensile strength of not less than sixty thousand pounds to the square inch, and a ductility in eight inches of not less than twenty-five per centum."

I. All ship-plates, beams, angles, rivets, bolts, boiler-plates, and stays to be inspected and tested at the place of manufacture by a Naval Inspector of Material, and to be passed by him, subject to restrictions hereinafter mentioned, before acceptance by the ship-builders, whether Government or private, for incorporation into said vessels.

II. Every plate, beam, and angle supplied for these vessels to be clearly and indelibly stamped in two places, and with two separate brands: 1st. With that of the maker, which shall distinguish the name of the manufactory or company; 2d. With the regulation brand of the Naval Inspector of Material. The latter not to be stamped upon any of the above-mentioned material until it shall have passed an inspection for surface or other defects of manufacture and the physical tests have been accepted by the Inspector and have been stamped with the maker's brand.

In case of small articles passed in bulk the above-mentioned brands shall be applied to the boxing or packing material of the objects.

No steel material to be received at the building yards for incorporation into vessels except it bear, either upon its surface or that of its packing, both of these brands as evidence that it has passed the necessary Government inspection.

III. The weight of all plates, beams, angles, &c., must be obtained by the Inspector of Material before delivery.

Plates of 12½ lbs. per square foot or less, and strips and bars of 6 lbs. per lineal foot or less, may be accepted if the weights vary between 3 per cent. above and 5 per cent. below the specified weights.

All other plates and shapes may be accepted if the weights vary between the specified weights and 5 per cent. below them.

All plates and shapes not being within the limits here specified may be rejected.

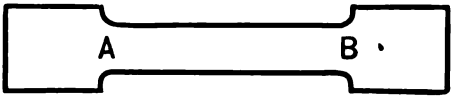
TESTS.

All material except boiler-plates shall be tested by heats as follows:

A specimen ingot or bloom shall be selected and rolled into a plate or bar and test pieces cut therefrom, provided always that the test pieces shall have received no more working than that which the finished material from the heat would receive.

Four test pieces, of the form shown in Fig. 1, for plates (square or round, in condition as finished at the rolls, may be used for the tests of shapes), shall be made and tested for each heat.

Fig. 1



The length A B must be at least 8 inches of uniform cross-section of which the area must not be less than $\frac{1}{2}$ nor more than $\frac{8}{10}$ of one square inch.

The reduction of width throughout the length A B should be just sufficient to prevent failure in the grips.

The test pieces must not be annealed unless the finished material is to be annealed.

Each test piece shall be submitted to a direct tensile stress, until it breaks, in a machine of approved character.

The initial stress to be 30,000 pounds per square inch.

The first load to be kept in continuous action for one minute.

An observation to be made of the corresponding elongation measured upon the original length of 8 inches.

The stress then to be increased slowly until the principal elastic limit is determined, after which additional loads will be added at intervals of time nearly as possible equal, and separated by half a minute, the loads to produce an increase of stress of 5,000 pounds per square inch of original section of the test piece, until the stress is about 50,000 pounds per square inch of original section, when increments of stress must not exceed 1,000 pounds per square inch. Upon close approach to the possible ultimate strength the load to be increased gradually and its maximum value carefully noted.

The final elongation to be that obtained after rupture.

A list of all ingots made from each heat must be supplied to the Inspector. Each ingot should be stamped in his presence with the number of the heat. He should also see the test plate or billet cut off, stamped, and rolled, and place a private stamp upon it in such a way that each test piece will have the impression of the stamp near one end.

CONDITIONS OF ACCEPTANCE.

In order to be accepted the average of the four test pieces must show an ultimate tensile strength of at least 60,000 pounds per square inch of original section, and a final elongation in 8 inches of not less than 25 per centum.

Material which shows a strength greater than 60,000 pounds per square inch will be accepted, provided the ductility remains at least 23 per centum.

CASES OF FAILURE.

If the average of these four test pieces, numbered 1, 2, 3, and 4 (called Test I), fall below either of the required limits, the ingot from which pieces 1, 2, 3, and 4 were cut shall be rejected, and Test II made, consisting of pieces 5 and 6 cut from a second ingot: if the mean of the results of these two fall below either of the above limits the entire lot shall be rejected. If it be successful; Test III, or the mean of pieces 7 and 8 cut from a third ingot, shall decide.

If in any of the Tests I, II, III any single piece shows a tensile strength less than 58,000 pounds, or a final elongation less than 21 per cent., the ingot from which it was taken shall be rejected and that test considered to have failed, regardless of its average.

QUENCHING TEST.

IV. A test piece shall be cut from each plate, angle, or beam, and after heating to a cherry-red plunged in water at a temperature of 82° Fahrenheit. Thus prepared it must be possible to bend the pieces under a press or hammer so that they shall be doubled round a curve of which the diameter is not more than one and a half times the thickness of the plates tested, without presenting any traces of cracking.

These test pieces must not have their sheared sides rounded off, the only treatment permitted being taking off the sharpness of the edges with a fine file.

Inspectors may require a cold-bending test when considered necessary.

ANGLES, BEAMS, BULB-BARS, T-BARS, ETC.

V. Angle-bars are to be subjected to the following additional tests: A piece cut from one bar in twenty to be opened out flat, while cold, under the hammer; a piece cut from another bar in the same lot shall be closed until the two sides touch, while cold.

Bulb and T-bars are to be submitted to a closing test similar to that prescribed for angle-bars.

Bars submitted to these tests must show neither cracks, clifts, nor flaws.

RIVETS.

Each 1,000 lbs. of rivets from the same heat of metal shall constitute a lot; and be accompanied by two sample bars, each 18 inches long, for tensile test. These samples for tensile test shall be cut from the bars from which the lot of rivets is made, and be stamped with a number which shall also be placed on each box or package of that lot.

These samples to be subject to the same tensile test as that required for the plates.

The lot of rivets from which this sample bar does not fulfill the requirements of tensile strength and elongation required for plates, is to be rejected.

From each lot, six rivets are to be taken at random and submitted to the following tests, two rivets to be used for each test: 1st. Two rivets to be flattened out cold under the hammer to a thickness of one-half the diameter, without showing cracks or flaws. 2d. Two rivets to be flattened out hot under the hammer to a thickness one-third the diameter, without showing cracks or flaws. 3d. Two rivets to be bent cold into the form of a hook with parallel sides, without showing cracks or flaws.

BOILER MATERIAL

Two tensile test pieces shall be cut from each plate rolled for boilers; and one quenching test piece, which shall be tested as before described, except that, in the tensile tests, the initial stress may be 25,000 lbs. to the square inch.

The limits of strength for all plates, braces, stays, angles, and T-bars, shall be as follows:

The ductility in eight inches must not be less than 25 per centum, and the ultimate tensile strength must not be less than 57,000 lbs. and not more than 63,000 lbs.; and no single piece must show a less tensile

strength than 57,000 lbs. to the square inch, except plates for flanging and those used in the construction of the furnaces, which will have an ultimate tensile strength of not less than 50,000 and of not more than 55,000 lbs., and a ductility in eight inches of not less than 29 per cent.

No steel for boilers which is to be worked at a heat or to be annealed after working in the boiler-shops, shall be annealed at the works.

The acceptance of material under these tests will not relieve the contractor from the necessity of making good any material which fails in working or may be rejected by the Inspector.

TEST OF HOLLOW STEEL SHAFTS.

1. Each length of rough-forged shaft shall have a piece cut from it, at that end which was uppermost in the ingot, of sufficient size to allow the removal of specimens for tensile test parallel with the axis of the shaft, having a measured length of 4 inches between reference marks and of $\frac{1}{4}$ square inch sectional area when finished.

2. From the piece so removed four test pieces shall be taken, two at circumference of finished diameter and two at $\frac{1}{2}$ radius from center. These pieces to be broken in a machine of approved character, under the same conditions as prescribed for "Tests of Steel for Cruisers."

3. The ultimate tensile strength of the four pieces must be within the limits of 26 and 30 tons (of 2240 lbs.) per square inch, and that of no single piece may fall below 25 tons. Pieces showing greater tensile strength than 30 tons will be accepted, provided the required ductility and other tests are satisfied.

The ductility of no piece at outer radius may be less than 20 per cent., and that of no piece of inner radius less than 16 per cent., in the measured length of 4 inches.

4. Bars $\frac{1}{2}$ inch thick, cut at the outer radius, must stand bending double to an inner diameter of $1\frac{1}{2}$ inches after common quenching in water, from a low cherry-red temperature.

5. Pieces cut from the rough-forged shaft for test, may not be subjected to any subsequent treatment or process.

6. Inspectors of steel shafting shall have full facilities to assure themselves of the general good quality of the metal and of a satisfactory method of manufacture, and may reject any piece considered to be defective in quality or fabrication, without regard to the prescribed tests.